The Egyptian Journal of Hospital Medicine (January 2025) Vol. 98, Page 162-167

New Echo parameters for Detection of the Culprit Lesion Site and Evaluation of its Severity in Acute Inferior wall Myocardial Infarction

Sherif Ali Ezzat M. Nasrallah, Mohammed Wafaie Abo EL-Einein,
Mahmoud Hassan Shah, M Amin, Radwa Muhammad Abdullah
Department of Cardiology, Faculty of Medicine, Zagazig University, Egypt
***Corresponding author:** Sherif Ali Ezzat M. Nasrallah**, Email:** dr85sherif@gmail.com, **Tel:** 01006994403

ABSTRACT
Background: Because it can detect subtle myocardial damage and localize ischemic territories according to coronary lesions, speckle tracking echocardiography (STE) is a widely accessible noninvasive technique that can quickly and easily provide additional information over basic echocardiography. It also provides a clear visualization with a "polar map" that is helpful for differential diagnosis and treatment. So, we aimed at early detection of the culprit lesion site and evaluation of its severity in acute inferior myocardial infarction by echocardiography and its different modalities.
Methods: This cross-sectional study was conducted ~~at~~ on 66 patients with acute inferior myocardial infarction in CCU, Echocardiography unit and catheterization Laboratory of Cardiology Department, Zagazig University Hospitals, Nasser Institute and National Heart Institute during the period from July 2020 to July 2022. All patients were managed according to guidelines. **Results:** As regards 2D echocardiographic findings, there was a statistically significant difference among our studied groups regarding end diastolic volume (EDV), end systolic volume (ESV), ejection fraction (EF), wall motion score index (WMSI) where it was statistically higher in proximal RCA than Distal RCA and LCX (p-value < 0.05). There was a statistically significant difference among our studied groups as regards GLS where it was statistically higher in proximal RCA than Distal RCA and LCX (p-value < 0.05).
Conclusion: We concluded that IVC CI, GLS and Culprit Score can be considered as detectors to identify the site of the culprit lesion and its severity in cases with acute inferior wall MI.
Keywords: Echocardiography, 2D-STE, acute inferior myocardial infarction

INTRODUCTION
A non-invasive diagnostic method that offers important insights into heart hemodynamics and function is echocardiography. Two-Dimensional (2D) echocardiography provides a quick and efficient way to assess regional systolic function in clinical practice. In order to quantify the degree of contraction, the left ventricle (LV) is separated into multiple segments in each imaging plane, and each segment is given a numerical number. Usually, the segmentation follows the coronary artery distribution, enabling a quicker assessment of ischemia regions [(1)].

Numerous investigations have demonstrated the great sensitivity of 2D echocardiography, both qualitatively and statistically, and its diagnostic potential in acute myocardial infarction (AMI) was identified early. Since wall thickening is less affected by heart rate and loading conditions, it is typically recommended over wall motion for distinguishing between normal and infarcted myocardial. Particularly during the acute stage of AMI, wall thickening offers more accurate information for determining the degree of myocardial damage and viability [(2)]. Echocardiography is the preferred imaging technique for identifying right ventricular (RV) infarction, and there is a strong correlation between infarction and contractile failure. RV dilatation, Typical 2D echocardiographic findings in RV infarction include paradoxical septal motion, aberrant segmental wall motion, and RV systolic dysfunction [(3)]. Characteristic echocardiographic findings include dilation of the inferior vena cava with reduced or nonexistent inspiratory collapsibility, elevated right atrial pressure, and a movement of the interatrial septum towards the left atrium (LA) in the context of right ventricular dysfunction brought on by RV infarction. These results are essential for risk assessment and management since they have a high correlation with clinical condition and prognosis [(4)]. A new development in cardiac imaging is speckle tracking echocardiography in two dimensions (2D-STE). When assessing the function of the left ventricle (LV) in various clinical scenarios, including coronary artery disease (CAD), 2D-STE is more sensitive than traditional echocardiography. It gives important information about myocardial viability, ischemia, and infarction and enables the accurate assessment of myocardial deformation (strain). According to studies, 2D-STE is more accurate than traditional echocardiography at predicting prognosis and detecting subtle localized dysfunction [(5)].

AIM OF THE WORK
The present work aimed to early detection of the culprit lesion site as well as evaluation of its severity in acute inferior myocardial infarction by echocardiography and its different modalities.

METHODS
This cross-sectional study was conducted in CCU, Echocardiography Unit and catheterization Laboratory of Cardiology Department, Nasser Institute, National Heart Institute, and Zagazig University Hospitals from July 2020 to July 2022. Our study included 66 patients presented with acute inferior myocardial infarction divided into ~~to~~ 3 groups according to the culprit lesion into proximal RCA, distal RCA, and LCX groups. This study was done in the era of COVID-19 pandemic when physical and psychological stress prevailed and risk factors as

Received: 29/07/2024
Accepted: 29/09/2024

hypertension and physical inactivity prevailed. All patients provided a written informed permission, and Zagazig University's IRB # authorized the study. The study was conducted in compliance with the World Medical Association's Declaration of Helsinki, which is their code of ethics for research involving human subjects.

Inclusion criteria included individuals who are candidates for coronary angiography and have an acute inferior wall myocardial infarction. Poor echo window, pulmonary embolism, atrial fibrillation, valvular heart disease more than mild, left bundle branch block, Exclusion criteria included left ventricular enlargement and previously documented impaired left ventricular function.

Every patient had a comprehensive history taken and demographic information gathered. A thorough medical and cardiac history, including cardiovascular risk factors, age, gender, admission cholesterol levels above 200 mg/dl, and blood pressure readings of at least 140 systolic and/or 90 diastolic on two separate occasions are also required. comprehensive clinical examination that includes blood pressure and pulse, veins in the neck, edema in the lower limbs, evaluation of the chest and abdomen, and heart examination, which involves palpation, auscultation, and observation. On admission, an electrocardiogram (ECG) was carried out using a paper speed of 25 mm/s and an amplification of 10 mm/mv. Serial ECGs and ongoing monitoring were carried out if the initial ECG was not diagnostic, but the patient was still exhibiting symptoms and there was a high suspicion of an acute myocardial infarction. ST-segment shifts were identified 80 ms after the J-point for ST-segment depression and 20 ms after this point for ST-segment elevation, using the prior TP segment as the baseline. To check for RV infarction, an ECG was taken on the right side. ST elevation >1 mm in two continuous leads in inferior chest leads was used to differentiate the ECG. Using the culprit score, which is calculated as II – V2 / (III + V1 – aVL), proximal RCA lesions were diagnosed with a Culprit Score of ≤0.5, distal RCA lesions with a Culprit Score of 0.5–1.5, and LCx lesions with a Culprit Score of ≥1.5.

Cardiac enzymes and troponin:

Blood samples for CPK and CKMB were taken both at admission and twelve hours later. On admission and six to eight hours later, A Troponin T measurement (Roche Diagnostics, detection limit 0.1ng/ml) was conducted; values above 0.1ng/ml will be considered positive if the first set is negative.

Echocardiography:

Following an inferior myocardial infarction episode, a standard transthoracic echocardiogram was performed to evaluate the ventricular and left atrial diameters in the M mode parasternal view. The ejection percent will be calculated in 2D-mode in the apical 2- and 4-chamber apical views using the modified Simpson's biplane mode. Evaluation of the left ventricular segments' regional wall motion in accordance with AHA recommendations [6]. Measuring the **inferior vena cava collapsibility index** which is calculated as (IVC exp - IVC insp)/ (IVC exp) x100. As IVC CI is considered normal in the range of 20-40% [7].

Speckle tracking echocardiography:

GE E95 and Philips Epic 7 cardiac ultrasound systems use left ventricular global longitudinal strain (GLS) using the 2-dimensional speckle tracking echocardiography (2D-STE) modality. Three apical views (two-, three-, and four-chamber) and the parasternal short-axis views at the level of the papillary muscles were used to choose three beat cine-loop clips. The apical four chamber view's basal, mid, and apical antero-lateral wall segments as well as the apical inferior septal wall were used to assess longitudinal strain (LS). The apical two chamber view's basal, mid, apical anterior, and apical inferior wall segments were used to assess LS. LS was evaluated using the basal, mid, apical infero-lateral wall, basal, mid, and apical antero-septal segments from the apical long axis view. The mean strain of all 17 segments has been used to compute global longitudinal strain. After exporting, these photos were examined offline. A single frame at end systole is manually traced from the endocardial to the midwall using a point-click technique, ensuring that the region of interest encompasses at least 90% of the myocardial wall thickness. In later frames, the tracing's periodic movement was automatically monitored. The software calculated the tissue velocity by dividing the duration between B-mode frames by the movement of the spots. The software used the velocity to automatically calculate the strain [8].

Coronary angiography:

Through the right femoral artery's sheath, left and right guiding catheters are inserted (transfemoral technique). The left guiding catheter is injected with a dye to examine the left main coronary artery and its branches. The right guiding catheter is infused with dye to examine the right coronary artery (RCA). view of the left main coronary artery and its branches, such as the left anterior descending artery and the left circumflex [LAD], and any ramus. Then, if a lesion is present, evaluation and appraisal of its severity. The right coronary artery (RCA) is then seen, and the severity is evaluated and assessed.

Statistical analysis

The collected data was computerized and statistically analyzed using SPSS (Statistical Package for Social Science) version 24.0. The qualitative data was represented using percentages and frequencies. The Chi-square test was used to determine the difference between the qualitative variables. Quantitative data were expressed as mean ± SD (standard deviation). The means of the two groups were compared using the Student T test. Additionally, for non-parametric data, the Mann-Whitney test was computed. Two numerical variables were correlated using Spearman correlation.

The significance (P-value) of the results was assessed at the <0.05 level.

RESULTS

Table (1): Shows demographic data among the studied population

	Demographic data	RCA Prox. (n=29)	RCA Dist. (n=17)	LCX (n=20)	Test value	p-value	Sig
Age (years)	Mean± SD	55.90±11.94	51.82±10.77	60.55±12.54	2.519	0.089	NS
	Range	26-79	32-70	42-90			
Sex	Male	17 (58.6%)	15 (88.2%)	15 (75.0%)	4.786	0.091	NS
	Female	12 (41.4%)	2 (11.8%)	5 (25.0%)			
	Risk factors						
Hypertension	No	12 (41.4%)	8 (47.1%)	11 (55.0%)	0.882	0.643	NS
	Yes	17 (58.6%)	9 (52.9%)	9 (45.0%)			
Diabetes	No	16 (55.2%)	11 (64.7%)	12 (60.0%)	0.413	0.814	NS
	Yes	13 (44.8%)	6 (35.3%)	8 (40.0%)			
Smoking	No	10 (34.5%)	4 (23.5%)	5 (25.0%)	2.943	0.567	NS
	Ex. Smoker	1 (3.4%)	1 (5.9%)	3 (15.0%)			
	Active smoker	18 (62.1%)	12 (70.6%)	12 (60.0%)			
Dyslipidemia	No	17 (58.6%)	8 (47.1%)	9 (45.0%)	1.061	0.588	NS
	Yes	12 (41.4%)	9 (52.9%)	11 (55.0%)			
Family History	No	24 (82.8%)	12 (70.6%)	15 (75.0%)	0.988	0.610	NS
	Yes	5 (17.2%)	5 (29.4%)	5 (25.0%)			

Using: One-way Analysis of Variance test was performed for Mean±SD, x^2: Chi-square test for Number (%) or Fisher's exact test, when appropriate, NS: Non-significant; S: Significant; HS: Highly significant.

Table (1) shows demographic data among the studied population. It was divided according to the culprit vessel into 3 groups proximal RCA, Distal RCA and LCX groups, and showed that there was no statistically significant difference among the 3 groups and male represented 58.6%, 88.2%, 75.0% of proximal RCA, distal RCA and LCX lesions respectively, age of the studied patients with proximal RCA ranging from 26-79 years old with mean 55.90±11.94 years old while age of the studied patients with distal RCA ranging from 32-70 years old with mean 51.82±10.77 years old and the age of the studied patients with LCX ranging from 42-90 years old with mean 60.55±12.54 years old. Also, the table compared the population under study based on risk factors and found no statistically significant differences in the relationship between the culprit lesion and hypertension, diabetes, smoking, dyslipidemia, and family history.

Table (2): Comparison among the studied population according to 2D echocardiographic findings

2D Echocardiography	RCA Prox. (n=29)	RCA Dist. (n=17)	LCX (n=20)	Test value	p-value	Sig
EDV (ml)						
Mean±SD	101.34±18.66	90.15±20.37	89.01±7.08	4.141	0.020	S
Range	71.2-146.1	59.1-126.2	78.41-101.3			
ESV (ml)						
Mean±SD	64.97±21.17	52.61±18.08	36.20±7.92	16.274	0.000	HS
Range	29.4-114.2	26.5-78.64	23.6-55.41			
EF%						
Mean±SD	37.07±11.73	42.90±10.08	59.64±6.50	30.960	0.000	HS
Range	19.03-60.38	28.92-60.38	42.2-69.9			
WMSI						
Mean±SD	1.45±0.16	1.35±0.15	1.11±0.10	34.070	0.000	HS
Range	1.11-1.82	1.11-1.64	1-1.35			
IVC CI (%)						
Mean±SD	20.48±4.54	26.18±5.27	32.05±4.73	34.745	0.000	HS
Range	14-35	17-36	22-40			
GLS						
Mean±SD	-11.60±2.46	-13.80±1.57	-18.21±1.36	67.245	0.001	HS
Range	-15.4 - -6.2	-15.98 - -9.9	-20.5 - -16.3			

Using: One-way Analysis of Variance test was performed for Mean±SD & Multiple comparison between groups through Post Hoc test: Tukey's test , NS: Non-significant; S: Significant; HS: Highly significant.

Table (2) show comparison among the studied population according to 2D echocardiographic findings. The proximal RCA, distal RCA, and LCX groups differed statistically significantly in terms of wall motion score index, ejection fraction (EF), end diastolic volume (EDV), and end systolic volume (ESV). (WMSI), inferior vena cava collapsibility index (IVCCI), and global longitudinal strain (GLS).

Figure 1,2; showed correlation between GLS and different parameters among the studied population, using Pearson's correlation coefficient (r).

There was a positive correlation between GLS and ejection fraction. Also, the figures showed negative correlation between GLS and EDV, ESV, WMSI, number of vessels affected in coronary angiography, and SYNTAX score.

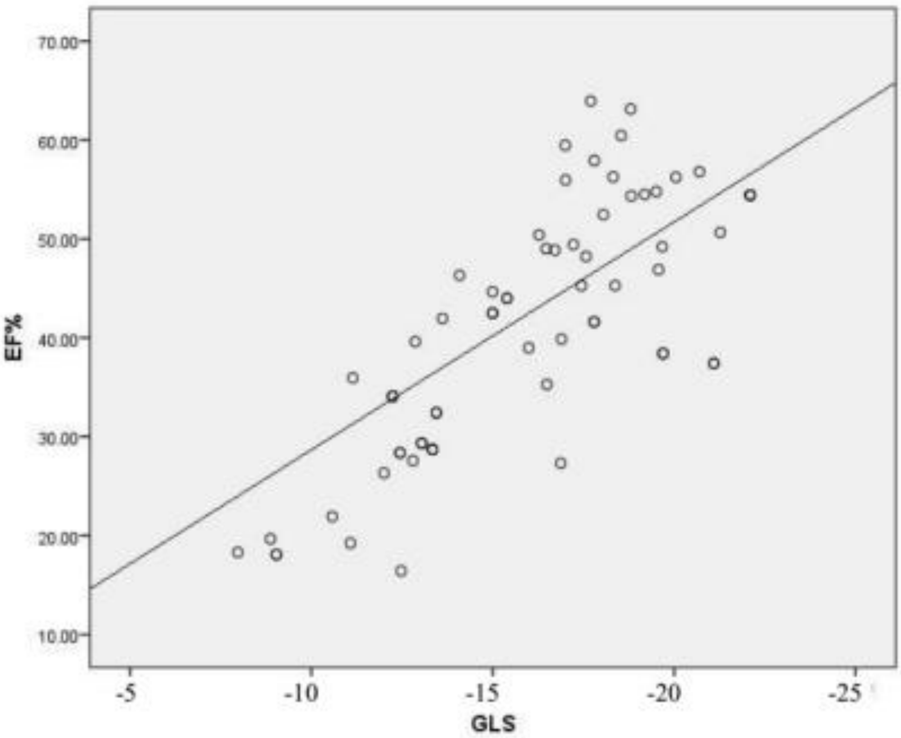

Figure (1): Scatter plot of correlation between GLS and EF%.

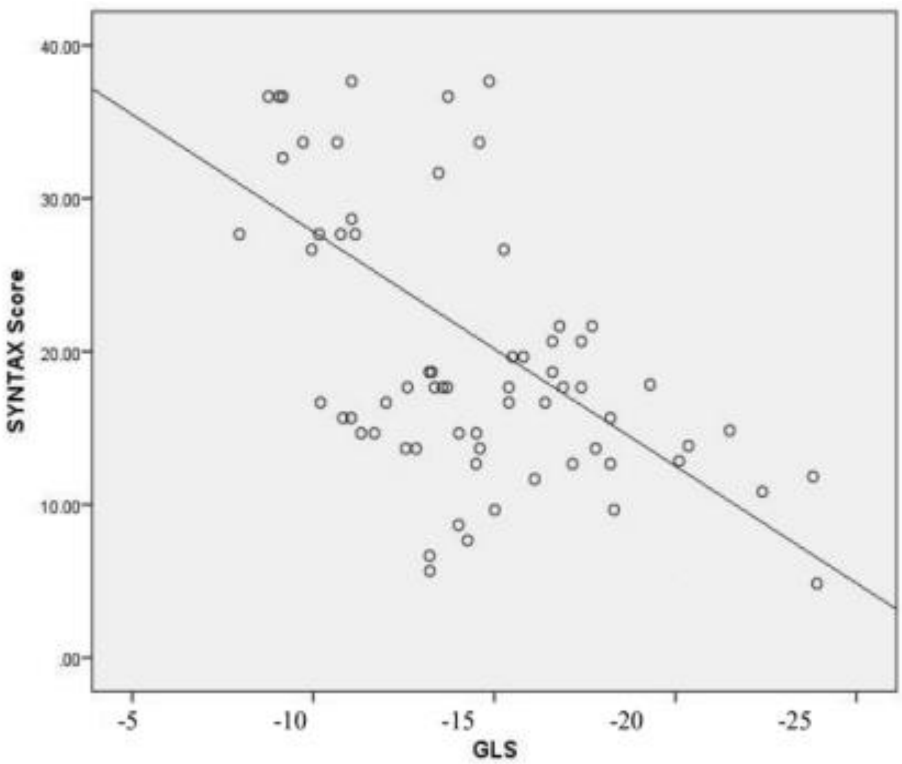

Figure (2): Scatter plot of correlation between GLS and SYNTAX score.

DISCUSSION

Regarding risk variables and demographic data, there were no statistically significant differences between the groups in the present study.

This concurred with **Atici *et al.*** [9], **Yıldırımtürk *et al.*** [10] **, and Zhao *et al.*** [11] who found no appreciable variations in the groups' levels of hyperlipidemia, smoking status, diabetes mellitus, and hypertension, but **Sarvari *et al.*** [12] as well as **Giridharan *et al.*** [13] revealed that the prevalence of substantial coronary obstruction was higher in men than in women. This was mostly due to the fact that the population under study was much older, which eliminated the physiological protection that comes naturally to women.

According to our study's 2D echocardiographic results, the proximal RCA group had higher EDV, ESV, and WMSI than the other two groups (P-values = 0.02, 0.0001, and 0.0001, respectively). whereas the proximal RCA group had lower GLS and EF than the other two groups (P-value = 0.001 and 0.0001, respectively). The proximal RCA group had a higher EDV (101.34±18.66) than the distal RCA group (90.15±20.37), and the distal RCA group had a higher EDV (90.15±20.37) than the LCX group (89.01±7.08), P=0.02. Additionally, ESV was higher in the proximal RCA group (64.97±21.17) than the distal RCA group (52.61±18.08), and it was higher in the distal RCA group (52.61±18.08) than in the LCX group (89.01±7.08), P=0.0001, and (36.20±7.92). Furthermore, the proximal RCA group had a reduced ejection percentage (EF). (37.07±11.73) than in the distal RCA group (42.90±10.08), and it was lower in the proximal RCA group (42.90±10.08) than in the LCX group (59.64±6.50), P=0.0001. Additionally, the proximal RCA group (1.45±0.16) had a higher wall motion score index (WMSI) than the distal RCA group (1.35±0.15), and the proximal RCA group (1.35±0.15) had a higher WMSI than the LCX group (1.11±0.10), P=0.0001. Additionally, these outcomes were roughly equivalent to **Ismail *et al.*** [14] who, although their study did not achieve statistical significance, discovered results that were comparable to ours and demonstrated a difference between the proximal, mid, and distal RCA and LCX groups. Additionally, the proximal RCA group in our population may have a higher syntax score and a higher prevalence of multivessel disease, which could explain our findings.

The GLS results of our investigation showed that the groups differed statistically significantly, with the proximal RCA group having worse GLS than the other two groups. (P-value = 0.001). The proximal RCA group (-11.60±2.46) had a higher GLS impairment than the distal RCA group (-13.80±1.57), and the distal RCA group (-13.80±1.57) had a higher GLS impairment than the LCX group (-18.21±1.36), P=0.001. In accord with us were ***Zuo et al.*** [15] **, Atici *et al.*** [9]**, Giridharan *et al.*** [13] They found that there was a significant variation in GLS across the study groups with respect to the culprit lesion. Furthermore, consistent with our findings, **Ersbøll *et al.*** [16] **, Grabka *et al.*** [17] **and Meimoun *et al.*** [18] investigated the connection between the culprit lesion site and GLS in AMI patients. and explained that the best independent predictor of the location of the culprit lesion was GLS.

Speckle tracking echocardiography was used in our study to correlate the Global Longitudinal Strain (GLS) with the traditional echocardiographic indices, LVEF, LVEDV, LVESV, and WMSI. We found that GLS had a substantial positive connection with EF and a significant negative correlation with EDV, ESV, and WMSI. (r = 0.365& P-value = 0.003). These results are consistent with **Cimino, *et al.*** [19] who evaluated 20 STEMI patients' global (GLS) using 2D-STE and discovered a significant relationship between GLS and LVEF measured using 2D-echo **Cimino *et al.*** [19]. Also, we agreed with **Mistry *et al.*** [20] They evaluated LV function in 163 STEMI patients by contrasting GLS with other non-invasive imaging techniques. They discovered a strong correlation between global strain and EF as determined by all modalities. The most reliable indicator of low EF as determined by the gold standard magnetic resonance was global strain. These statistics might be of health economic significance because global strain is a cheap test.

We concurred with **Amira *et al.*** [21] who made the report GLS and EF have a statistically significant proportional correlation, and GLS and WMSI have a statistically significant inverse correlation.

LIMITATIONS

As far as we are aware, this study seems to be the first cross-sectional investigation to examine the function of GLS in identifying the lesion site of an acute inferior wall myocardial infarction. There is little information on the differences between RCA-caused inferior wall myocardial infarction (MI) and LCX occlusion. The sample size is small with insufficient randomization. A brief follow-up time to validate our findings. Results may be interpreted biasedly if the groups under study are not properly matched with respect to baseline clinical and angiographic data. Strict regional analysis is not always correct because of the 3-epicardial coronary artery perfusion overlap, individual patients' coronary artery structural variations, as well as the microvascular networks that connect coronary arteries, which might result in zones of dual arterial perfusion. Age, hypertension, diabetes, and other conditions may also have an impact on 2D strains.

CONCLUSION

We concluded that in situations with acute inferior wall MI, IVC CI, GLS, and Culprit Score can be used as detectors to determine the location of the culprit lesion and its severity.

REFERENCES

1. **Nagueh F, Smiseth A, Appleton P *et al.* (2016):** Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J Am Soc Echocardiogr., 29, 277-314.
2. **Shah M, Cikes M, Prasad N *et al.* (2019):** Echocardiographic Features of Patients With Heart Failure and Preserved Left Ventricular Ejection Fraction. J Am Coll Cardiol., 74, 2858-2873.
3. **Wen N, Lee W, Fang F *et al.* (2014):** Beyond auscultation: acoustic cardiography in clinical practice. Int J Cardiol., 172, 548-560.
4. **Sun Y, Li Q, Li J *et al.* (2023):** Echocardiographic evaluation of the right atrial size and function: Relevance for clinical practice. Am Heart J Plus., 27, 10-27.
5. **Hubbard T, Arciniegas Calle C, Barros-Gomes S *et al.* (2017):** 2-Dimensional Speckle Tracking Echocardiography predicts severe coronary artery disease in women with normal left ventricular function: a case-control study. BMC Cardiovasc Disord., 17, 23-40.
6. **Grundy M, Stone J, Bailey L *et al.* (2019):** 2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS /APhA/ASPC/NLA/PCNA guideline on the management of blood cholesterol: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol., 73, 285-350.
7. **Özcan S, Güngör B, Tatlısu A *et al.* (2014):** Presence of early repolarization on admission electrocardiography is associated with long-term mortality and MACE in patients with STEMI undergoing primary percutaneous intervention. J Cardiol., 64, 164-170.
8. **Lang D, Holzem K, Kang C *et al.* (2015):** Arrhythmogenic remodeling of β2 versus β1 adrenergic signaling in the human failing heart. Circ Arrhythm Electrophysiol., 8, 409-419.
9. **Atici A, Barman A, Durmaz E *et al.* (2019):** Predictive value of global and territorial longitudinal strain imaging in detecting significant coronary artery disease in patients with myocardial infarction without persistent ST-segment elevation. Echocardiography, 36, 512-520.
10. **Yıldırımtürk Ö, Aslanger E, Bozbeyoğlu E *et al.* (2020):** Does electrocardiogram help in identifying the culprit artery when angiogram shows both right and circumflex artery disease in inferior myocardial infarction? Anatol J Cardiol., 23, 318-323.
11. **Zhao N, Zhang L, Zhang X *et al.* (2022):** Application of Layered Strain Technique in NSTE-ACS. Cardiovasc Ther., 2022, 24-26.
12. **Sarvari I, Haugaa H, Zahid W *et al.* (2013):** Layer-specific quantification of myocardial deformation by strain echocardiography may reveal significant CAD in patients with non-ST-segment elevation acute coronary syndrome. JACC Cardiovasc Imaging, 6, 53-54.
13. **Giridharan S, Karthikeyan S, Aashish A *et al.* (2021):** Two-dimensional speckle tracking echocardiography derived post systolic shortening in patients with unstable angina and normal left ventricular systolic function. Anatol J Cardiol., 25, 880-886.
14. **Ismail A, Mageed R, Ashmawy M *et al.* (2023):** Correlation between echocardiographic and primary percutaneous coronary intervention for proximal right coronary artery in inferior-wall myocardial infarction. Tanta Med J., 51, 2-12.
15. **Zuo J, Yang T, Liu G *et al.* (2018):** Global Longitudinal Strain at Rest for Detection of Coronary Artery Disease in Patients without Diabetes Mellitus. Curr Med Sci., 38, 413-421
16. **Ersbøll M, Valeur N, Mogensen M *et al.* (2012):** Relationship between left ventricular longitudinal deformation and clinical heart failure during admission for acute myocardial infarction: a two-dimensional speckle-tracking study. J Am Soc Echocardiogr., 25, 12-91.
17. **Grabka M, Wita K, Tabor Z *et al.* (2013):** Prediction of infarct size by speckle tracking echocardiography in patients with anterior myocardial infarction. Coron Artery Dis., 24, 127-34.
18. **Meimoun P, Abouth S, Clerc J *et al.* (2015):** Usefulness of two-dimensional longitudinal strain pattern to predict left ventricular recovery and in-hospital complications after acute anterior myocardial infarction treated successfully by primary angioplasty. J Am Soc Echocardiogr., 28, 13-75.
19. **Cimino S, Canali E, Petronilli V *et al.* (2013):** Global and regional longitudinal strain assessed by two-dimensional speckle tracking echocardiography identifies early myocardial dysfunction and transmural extent of myocardial scar in patients with acute ST elevation myocardial infarction and relatively preserved LV function. Eur Heart J Cardiovasc Imaging, 14, 5-11.
20. **Mistry N, Beitnes O, Halvorsen S *et al.* (2011):** Assessment of left ventricular function in ST-elevation myocardial infarction by global longitudinal strain: a comparison with ejection fraction, infarct size, and wall motion score index measured by non-invasive imaging modalities. Eur J Echocardiogr., 12, 67-83.
21. **Amira M, Wael S, Randa A (2016):** Speckle Tracking Echocardiography in Diabetic Patients with STEMI. Med J Cairo Univ., 1579-1585.